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ABSTRACT

This report surveys many of the recent investigations on calculators and their use in mathematics education. The review notes that the widespread availability of hand-held calculators and their affordability has led to their consideration as a viable tool to aid in mathematics instruction. The studies reviewed suggest that many questions are still unanswered, with the majority of studies that compared groups using or not using calculators either favoring the calculator group slightly or reflecting no significant differences. This result is considered unique to the typical case in mathematics education, with the positive trend lending support to the common sense belief of many mathematics educators that calculators will not adversely affect achievement. Many of the studies reviewed are seen as similar in that they are not concisely reported, are ambiguous, and have serious methodological flaws. Other problems with the research are pointed out, and further investigation of this new and developing area is suggested. (MP)

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Hand-Held Calculators in the Classroom: A Review of the Research

by

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The recent widespread availability of hand-held calculators and the even newer affordability of them has led to their consideration as a viable tool to aid mathematical instruction. Parents and teachers alike are concerned over the effects of calculator use on the basic mathematical skills. Some experts argue that calculator use results in the loss of thinking skills and knowledge of basic facts, while others see an increase in motivation and better understanding as a potential benefit. As a result, many professional groups have called for further experimentation with the use of calculators in the classroom.

Current research studies suggest that many questions are still left unanswered. The majority of the studies comparing the achievement of groups using or not using calculators either favor the calculator group slightly or reflect no significant differences in equal number. This is unique to the typical case in mathematics education. Here the bell shaped normal curve shows where most of the findings of no significant differences occur. Therefore, research dealing with calculators differs from others in mathematics in that a positive trend can be found. The common sense belief of many mathematics educators that calculators will not adversely affect achievement has some

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support.

Wheatley and Shumway (1979) observed that most of the studies done to date suffer from serious design, procedural, or interpretation problems such that few valid conclusions can be made. Suydam (1979) goes beyond this seeing a greater concern than these flaws, which are the focus of the majority of the studies. Most studies touch on broad, general questions of achievement relative to untold or vague use of the calculator. The effect on achievement is of some concern to all involved but she sees more important questions to explore. One such unexplored question is how learning could change with calculator use. Studies with such focus would have an obvious input on mathematics learnings, instruction, and curriculum but few have been attempted.

A study by Anderson (1977) compared the effects of restricted use, unrestricted use and no use of calculators on attitude, mastery of concepts, computational skill, and problem solving on the mathematical achievement of seventh grade students. He found a significant favorable effect on the attitude of students calculators but found no effect on overall achievement, mastery of concepts, computational skills and problem solving. He councluded that calculators could be placed in seventh grade mathematics classes without special curriculum changes or training of teachers and have no adverse effects. Wheatley and Shumway (1979) had similar results when studying the impact of calculator use for teaching elementary school mathematics (grades 2-6) on the achievement and attitude of students. The treatment

was designed to most likely represent an initial calculator experience schools would typically consider. No measurable detrimental effects for the first year use of calculators for teaching mathematics was found. For the group using calculators, a positive attitude towards mathematics was measured. The researchers related that children can learn to use calculators in thirty minutes and can perform computations more successfully than those children not using calculators. Informal observation imply that the curriculum possibilities for elementary schools using of calculators could be dramatic. Suggested are studies of the effects of larger, more intensive use of calculators.

Estimation skills taught with the use of calculators was studied by Sutherlin (1977). He investigated whether an experimental group of sixth grade students would score significantly higher on the posttest and/or retention tests. Scores on each test showed no significant difference between the experimental and control group. Calculator use did not provide any advantage in the learning of estimation skills. Time spent working with calculators did not, however, detract from the students' mathematical growth of those involved. The exhibited similarity between groups could have been, as the researcher noted, due to sixth graders' failure to view estimation skills as valuable and their unease with the imprecision of estimated answers. Two studies, Kobrin (1978) and Wilson (1977) investigated the effects of calculator use on the mathematical achievement of fourth, fifth, and sixth grade students. Both concluded that the mathematical achievement of pupils on these grades was not affected or had no

adverse effects from calculator use. Borden (1977) supported these findings for sixth grade students and added that students using calculators had more positive attitudes toward mathematics than those who did not.

An unique study in this area was made by Hawthorne and Sullivan (1975). Described as an open-ended exploratory study, its purpose was to discover how calculators could be used to advantage during sixth grade lessons. In this study, standardized tests were given but subjective reports of teachers, authors, and administrators provided the primary measures for evaluation. They observed that students experienced no difficulty in learning to use the calculator maintained a high level of interest throughout the school year. Students found calculators useful in checking problems and working with verbal problems. Recognized by the authors was the limitations of this type of study in making strong conclusions. They did conclude that calculators could be used to advantage in sixth grade classes with no adverse effects. Noted were the confounding variables of the enthusiasm of the teachers and the novelty of the calculators. They concluded that while it is not believed that "calculators have any great inherent ability to support and motivate mathematical study"... "with the strong direction of capable teachers, much can be accomplished (p. 33.)"

Sixth, seventh, and eighth grade remedial students were examined by Aldridge (1977) whose study was designed to

to determine the difference in achievement with use or non-use of calculators. Some interesting results occured. Here, sixth and seventh grade control groups outscored the experimental group significantly while the eighth grade experimental group outscored the control group but not significantly. From these results, the author reasoned that purchasing calculators for remedial mathematics below the eighth grade may not be justified. Kasnic (1978), on the other hand, found that the use of calculators by low-ability students helped them in competing more successfully with higher ability students. This study which looked at the effect of the use of calculators on mathematical problem-solving among sixth grade students had another seemingly disappointing conclusion. Calculators did not appear to substantially aid average and high ability students as one using calculators on posttests did not solve more problems than comparable students who did not use calculators.

Calculator use must be eventually examined for its affect on specific topics in mathematics as it is not a panacea for all areas. One such area is rational number-decimal - percent conversion algorithms as studied by Janski (1976). He found, based on scores on achievement instruments, that "...calculator use in general could not be judged to be successful with simplified rational - decimal - percent conversion algorithms (p. 45.)" This suggests a closer examination of the parts that make up mathematical achievement.

Studies showing a significant positive effect of calculators are by Spencer (1975) and Jones (1976). Spencer (1975) looked for the calculator's effect on computational skills and reasoning ability of fifth and sixth graders. She saw the calculator as a motivational device by freeing students from laborious computations thus allowing them more time to develop reasoning skills. Her research proved her correct by finding a significant difference in favor of the experimental group on scores of the reasoning test for both fifth and sixth graders. Grade six also showed a significant difference in favor of the experimental group on scores of both computation and total arithmetic test. Jones (1976) found basically the same positive results as the sixth graders examined using calculators had significantly greater achievement than those who did not in terms of total achievement, computation and concepts.

Many of the studies reported are disappointingly similar in the fact that they are not concisely reported, are ambiguous, and have serious methodological flaws. Therefore, the studies lack credibility causing the validity of the conclusions to be questioned. This would seem to be a common flaw when new topics of research are examined. Many studies failed to report or left unclear the specific nature of the instructional treatment for length, frequency, and nature of instruction. The set of activities, as used in the classroom should be made available for careful inspection. If we are to understand the effects of calculators

on mathematical achievement, the ways the calculator is to be used must be clearly defined. Time and methods of its usage are rarely measured and/or reported in the literature.

Uncontrolled and unacknowledged teacher effect was another variable seemingly overlooked. Training implementation of materials, and attitudes toward instructional treatment by teachers could have had a great effect on the results of these studies. Motivation factors also need a closer look. Few studies even considered or attempted to control the novelty effect of calculators. Frequent reporting of positive attitudes on the part of the experimental group could have resulted from this common oversight. Secondly, control group knowledge of the experimental groups' use of calculators could have shifted the positive attitude findings in favor of the experimental group. Other areas of difficulty encountered in the studies that would need further attention in future studies were the difficulties researchers had in attaining randomness and the fact that larger population studies are needed.

Analysis of the research found most studies of the effects of the use of a calculator on the mathematical achievement of Junior High students to show no signficant difference between the groups using the calculator and those who did not. There were, however, additional studies reflecting significantly higher achievement scores from calculator use than those not using calculators. Most studies also related a significant positive attitude towards

mathematics for the experimental group. This slight positive trend signals possible optimism for use of the calculator in mathematical instruction. Further study in this new and developing area could help to base this optimism on fact.

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